REMARKS

Reconsideration and allowance of the above-referenced application are respectfully requested. The undersigned gratefully acknowledges the Examiner's telephone call regarding the final rejections made in the Office Action dated July 28, 2003 and the notice of appeal filed on November 26, 2003.

Claims 1 and 6 have been amended to clarify their language. No new matter is added. Claims 1-11 remain pending.

1. Specification and Drawings

The amendment to the Brief Description of the Drawings does not add new matter because it simply conforms the text to the originally filed drawings in the parent Application No. 09/443,177 now U.S. Patent No. 6,271,537. The integrated values were labeled in the captions of the original drawings for FIGS. 4, 5, and 6. Hence, this objection should be withdrawn.

Applicants have considered the objections to drawings and are working on formal drawings to overcome the objections. It appears that examination of the pending claims on the merits is not affected by the indicated informalities in the drawings. Applicants respectfully request additional time for correcting such informalities.

2. Claim Rejections over Choi '015 and Chen

Claims 1-3, 5-8, and 10 stand rejected under 35 USC 103(a) over Choi '015 in view of Chen. Independent Claims 1 and 6 as amended are patentable because the alleged combination of Choi '015 and Chen fails to teach each claimed feature and because the alleged combination of Choi '015 and Chen cannot be properly made.

2.1. The alleged combination of Choi '015 and Chen fails to teach each claimed feature

The Patent Office contends that the combination of the empty cavities 251 and quantum-well stacks S with straight walls in FIGS. 5, 6, and 9 in Choi '015 and the 2D cross grids and the suggestion of various sidewall profiles created by wet chemical etching or dry etching in Chen teaches each of the claimed features in Claims 1-3, 5-8, and 10. This contention is not supported by the disclosures of Choi '015 and Chen.

First, Claims 1-3, 5-8, and 10 recite a plurality of quantum-well structures, arranged in columnar shapes and spatially separated from one another by a gap which is electrically insulating and state that each quantum-well structure has opposing parallel side walls perpendicular to said substrate. Notably, the recited quantum-well structures form an optical grating. As well understood in optics, the quantum-well structures are optically coupled together as a whole in order to form the optical grating. In the present invention, the quantum-well structures, optically coupled together as a whole, diffract received light to have polarization components that are perpendicular to the quantum well layers and the substrate in order to be absorbed by the quantum-well structures.

In contrast, the alleged combination of Choi '015 and Chen uses each pixel feature as a single optical element, without optical coupling with other pixel features, to redirect light. In the devices shown in FIGS. 5, 6, and 9 of Choi '015 that are specifically cited by the Patent Office,

> Cavities 251 are sized so that each one will function as ***an independent single-slit diffraction unit***. Specifically, if the width of cavity 251 is in the order of a small number of wavelengths of IR radiation R1, single-slit diffraction of IR radiation R1 at

> cavity 251 will take place, causing IR radiation R1 to break up and bend into a continuum of radiation components, e.g., radiation components R7, R8 and R9, directed at different angles most of which will be significantly closer to the desired plane in which absorption takes place. (emphasis added)

Col. 6, line 59-Col. 7, line 1.

This teaching of an independent single-slit diffraction unit in Choi '015 specifically teaches away from the recited formation of the optical grating by the quantum-well structures in the present invention because Choi '015 specifically makes the width of cavity 251 greater than the IR wavelength to be absorbed so that there cannot be optical coupling between adjacent cavities 251 in order to form independent single-slit diffraction units.

Similarly, Chen also specifically ***teaches away*** from the recited optical grating formed by quantum-well structures in the present invention. More specifically, Chen teaches the use of the corrugation shown in Fig. 1(c) to redirect normal incident light by the single slit diffraction and the corrugation shown in Fig. 1(b) to redirect normal incident light by the total internal reflection (TIR) from the slanted surfaces (Column 1, page 1432). These two optical mechanisms are distinctly different from the recited optical grating formed by the quantum-well structures of the present invention.

Therefore, the alleged combination of Choi '015 and Chen fail to disclose the present invention. For this reason alone, Claims 1-3, 5-8, and 10 are patentable.

Second, Claims 1-3, 5-8, and 10 recite that each quantum-well structure has opposing parallel side walls perpendicular to the substrate and forms an optical cavity. As illustrated in FIG. 1 of this application, this recited optical cavity is a solid column formed by the quantum well layers and the

surrounding gaps. In the words of Claim 1, the optical cavity is "in resonance with the wavelength" absorbed by the recited quantum-well structures. The alleged combination of Choi '015 and Chen fails to disclose this recited feature of the present invention.

In this regard, Choi '015 discloses cavities 251 with straight walls in stack S of quantum well layers of QGIP 220 (FIGS. 5, 6, 7, and 8). Although, the term "cavity" is used in Choi '015, the cavities 251 are in fact voids formed in the quantum well layers. Hence, inside each cavity 251, there are no light-absorbing quantum well layers. As such, each cavity 251 does not absorb light. Therefore, the cavity 251 is different from the recited optical cavity in the present invention. In addition, the cavities 251 are sized as independent single-slit diffraction units to diffract input light with normal incidence to allow for absorption by the quantum well layers in the stack S. Notably, the light-absorbing stack S is contiguous with embedded cavities 251 (FIG. 6) and thus is entirely different from the recited separated columnar quantum-well structures that form separate optical cavities in the present invention. As a comparison, the structural pattern in FIG. 6 of Choi '015 may be viewed as a photographic negative of the columnar quantum-well structures of the present invention to a certain extent.

Chen also completely lacks any disclosure on this aspect of the present invention. Chen describes corrugations with slanted side surfaces. In Chen's 1D and 2D designs, such opposing slanted surfaces, by virtue of their physical designs, cannot form optical cavities of the present invention. In fact, Chen specifically teaches that a normal incident light ray is bounced between different slanted surfaces of different corrugations multiple times with a thinned substrate (Fig. 2). Therefore,

Chen's design does not confine light between two opposing surfaces as the optical cavity of the present invention.

In addition, Chen's design is made so that the light coupling efficiency is "free of detection wavelength dependence and pixel size dependence" (Column 2, page 1431). In stark contrast, the optical cavity of the present invention is a device that is specific to a resonance wavelength and strongly depends on the detection wavelength. Notably in the present invention, the pixel size of the present invention is selected along with indices to make each columnar quantum-well structure to be in resonance with the wavelength to be absorbed. Therefore, Chen's design ***teaches away*** from the present invention.

In view of the above, the alleged combination of Choi '015 and Chen fails to disclose several features recited in Claims 1-3, 5-8, and 10. Therefore, Claims 1-3, 5-8, and 10 are patentable.

2.2. The alleged combination of Choi '015 and Chen cannot be properly made

Independent from the above arguments, Claims 1-3, 5-8, and 10 are patentable also because the alleged combination of Choi '015 and Chen cannot be properly made under 35 USC 103(a).

As discussed above, Chen uses properly slanted surfaces of corrugations in the quantum well structures to direct normal incident light through total internal reflection (TIR) so that the light coupling efficiency is "free of detection wavelength dependence and pixel size dependence" (Column 2, page 1431). In Column 1, page 1432, Chen states that

> *The **essential idea** of the C-QWIP is to create a maximum number of **slated sidewalls within the detector***

active region *to channel normal incident light into the parallel direction.*

As suggested by Chen, the ideal slanted surfaces may be at 45 degrees as used in the edge coupling detectors (Column 2, page 1431 and column 1, page 1433).

However, due to the wet etching used in Chen, the V grooves are defined and controlled by the crystallographic directions of the quantum well structures and can only form 50-degree slanted surfaces along one of the two orthogonal crystallographic directions. In the orthogonal crystallographic direction, an inverted V groove with a slanting angle of 70 degrees is formed. Unfortunately, the inverted V grooves reflect light away from the light-absorbing quantum-well region and thus degrade the detector performance (but they reduce the dark current).

In the above context, Chen concludes that further investigation is needed on various sidewall profiles created either by wet chemical etching or by dry etching to fully explore the potential of the C-QWIP (Column 2, page 1436). In Chen's view, the essential idea of the C-QWIP is to create a maximum number of ***slated sidewalls*** within the detector active region to channel normal incident light into the parallel direction. Therefore, Chen's suggestion on "various sidewall profiles" can only be interpreted as various "slanted" sidewalls, such as the slanted sidewalls at 45 degrees and removal of the inverted V grooves. U.S. Patent No. 6,545,289 to Gunapala and other two co-applicants of this application provides a solution to this problem caused by the natural crystallographic directions (filed herewith as an IDS).

The Patent Office completely ignores use of the total internal reflection (TIR) of slanted surfaces as the essential

idea for the C-QWIP in Chen. In its final rejection, the Patent Office states that

> It would be have been further obvious to the skill artisan, when modifying the Choi '015 QGIP so as to form a 2-D groove QGIP, to specifically employ plasma etching as opposed to wet etching—and thereby from vertical sidewalls instead of slanted sidewalls—for the purpose of preventing the decrease in absorption efficiency that results from the inverted pyramid profile that is associated with the wet-etching process.

This assertion by the Patent Office contradicts with Chen's own teaching for the slanted surfaces as the essential idea for the C-QWIP. Therefore, the alleged combination is improper under 35 USC 103(a).

Apparently, in lack of any support from Choi '015 and Chen and any support from other evidence, the Patent Office made the alleged combination based on hindsight after having the benefit of the disclosure of the present invention. Under 35 USC 103(a), the rejections cannot stand and must be withdrawn.

3. Claim Rejections over Choi '015 and Chen and Choi '469

Claims 4, 9, and 11 are also patentable over Choi'015/Chen and in further view of Choi '469 based on at least the above arguments. Also see arguments made in a prior response filed on April 30, 2003 with respect to Choi '469.

In summary, Claims 1-11 are patentable over the cited prior art and should be in full condition for allowance.

Applicant asks that all claims be allowed. Please apply all applicable charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

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